

Pharmacognostical and Chemical Studies on Vietnamese Ginseng, *Panax vietnamensis* Ha et Grushv. (Araliaceae)

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A new species of genus *Panax* L., Araliaceae, was discovered in 1973 in Vietnam and named *Panax vietnamensis* Ha et Grushv. in 1985. The morphological and eco-physiological properties as well as estimation of reserve potential have been studied extensively. The morphological characteristics of this plant in genus *Panax* are as follows. Flower: ovary is mostly unilocular and one-styled; fruit: mostly has one seed (85%) shaped like the kidney, and a mature fruit has a black spot on the apex. *Panax vietnamensis* has a great reserve potential and is distributed in a wide area in Central Vietnam located in latitude 15°N., longitude 108°E. and at elevation of 1,700–2,000 m above sea level. Identification of major saponins of *P. vietnamensis* and pharmacological activities of the extracts are also briefly summarized.

Introduction

Panax species occur in the northern hemisphere from the Central Himalaya to North America through China, Korea and Japan (Hara 1970; Zhou et al. 1975). This genus includes the well-known medicinal plant such as *Panax ginseng* C.A. Meyer (Ginseng), and botanical, phytochemical and medicinal studies on this genus have been elaborated extensively. In 1973, a new species of this genus was discovered in Vietnam and designated *Panax vietnamensis* Ha et Grushv. in 1985 (Dung et al. 1985). The botanical, phytochemical and pharmacological studies have been

mainly elaborated at the Science-Production Centre of Vietnamese Ginseng, Ho Chi Minh City (SPCVG, Director: N. T. Nham) (Nham 1989). The present review article concerns with the morphological and eco-physiological studies of this plant which has attracted much attention as a new medicinal resource. The phytochemical and pharmacological studies are also summarized.

Discovery

On March 19th, 1973, a Vietnamese research group of medicinal plants conducted by Dao Kim

Long discovered a new species of *Panax*, *P. vietnamensis*, in Ngoc Lay Region (Dakto District, Komtum Province, Central Vietnam) at the elevation of 1,800 m above sea level.

This herb grows in dense forests of high mountains with cold rain and fog nearly all the year round, and has been used as a "secret medicinal plant" of the Se-Dang ethnic minority living in this region. The details of botanical and medicinal histories of *P. vietnamensis* (local name: Cu Ngai Rom Con) are not clear, and only old sachems (host of family) have known the efficacy of this herb. They use it for the treatment of serious illness for their own families and villagers. They consider *P. vietnamensis* as an angelic medicine or a life saving drug which is effective in curing all the diseases. On long journeys, they use *P. vietnamensis* as a potent invigorate.

Estimation of Reserve Potential

The reserve potential of *P. vietnamensis* was estimated by means of the standard ecological procedure, affording the following results. One hundred and eight spots with high density of *P. vietnamensis* have

been discovered. These spots are extended to very wide superficies of thirteen mountainous villages of three districts in two provinces. In this study, 17,548 wild samples of *P. vietnamensis* in 1,032 quadrats were used for the investigation of morphological data (137,932 data were recorded), which permitted the accurate description of morphology and the determination of concrete ecology of this plant. This study also revealed a great reserve potential of wild *P. vietnamensis*, and it is noteworthy that 78.5% of the wild plants used in this study were more than ten years old. In 1980, the Vietnamese Government accepted the survey results and remarked these regions as a National Reserve of *P. vietnamensis* for the conservation, regeneration and large scale cultivation of this valuable medicinal plant. The natural *P. vietnamensis* region is located around latitude 15°N. and longitude 108°E. This is a mountainous region with more than fifty summits (higher than 1,500 m above sea level) including the highest mountain, Mt. Ngoc Linh (2,595 m) of the Central Annamitic Range.



Fig. 1. Palmate compound leaves and an umbel of fruits of *Panax vietnamensis* Ha et Grushv. Left. Fruits of orange-red colour without black spots on the apex of fruit. Right. Fruits with black spots on the apex of fruits.

Morphological Studies

The accurate morphological description of *P. vietnamensis* was obtained from the data of 17,548 wild specimens collected in 1978–1980 and also from those of the cultivated plants.

Panax vietnamensis is a herbaceous plant, perennial by rhizome, commonly 40–60 cm tall, sometimes reaching 1 m tall, and aggregates in small patches and areas.

Aerial Stem: Erect, smooth, green or light purple, 5–8 mm in diameter. Aerial stem commonly withers after the growth season every year. However, under the influence of climate and/or soil conditions, two or three stems of preceding years can sometimes survive on the same rhizome top. Because rhizomes may be branched many times and each branch bears two or three stems, the whole plant often forms a bush.

Leaves: Palmately compound and verticillate. Three, four or five (rarely six or seven for grown-up plant) leaves on each aerial shoot.

Petiole: 6–12 cm long.

Leaflets: oblong, lanceolate or oval, with dentate margins. Blade top is acute, sometimes very long. A leaf commonly composes of five leaflets (rarely three, six or seven). The middle leaflet is the biggest and the two leaflets close to the petiole are the smallest. The largest leaflet is 6–15 cm long and 3–6 cm wide. Venation is pinnate and popularly has ten pairs of secondary nerves. Nervules are reticulate and have rigid 1–2 mm hairs along the central nerve on both faces of leaflets. Lower-leaves are less hairy than upper-leaves.

Blade: green, thin and slender.

Inflorescence: It appears mostly on grown-up plants with three or more leaves. A stalk of umbel is 10–20 cm long and generally has one single terminal umbel, sometimes two, three or four umbellules. An umbel is 2.5–4 cm in diameter and has 50–120 flowers.

Peduncles: slender and 1–1.5 cm long.

Some specimens exhibit extraordinary inflorescence with panicles like those of *Angelica sinensis* (Oliv.) Diels. Umbelliferae, bearing 20–50 umbellules.

Flowers: Light green. The diameter of an open flower is 3–4 mm. Each flower comprises five sepals grouped in a bell-shaped cup with five small triangular teeth (1–1.5 mm long), five petals (1.5–2 mm long), five white stamens, slender filament (1.5–2 mm long) and dorsifixated oval anther. Calyx is lightly prominent. Ovary is unilocular and one-styled (85%), sometimes bilocular and two-styled. Style is 1–1.5 mm high. It is noteworthy that ovary trilocular and more as well as three-styled and more have not been found till now. The percentage of maturing of flowers is low.

Fruit: Berry red when mature, with one black spot on the apex. Red mature fruits without black spot have rarely been collected. Mostly, a fruit contains one seed shaped like kidney (8–12 mm long, 6–8 mm wide and 2 mm thick).

The seed surface is rough and the mean weight of a seed is 275 mg. Two-seeded fruits with ovoid shape

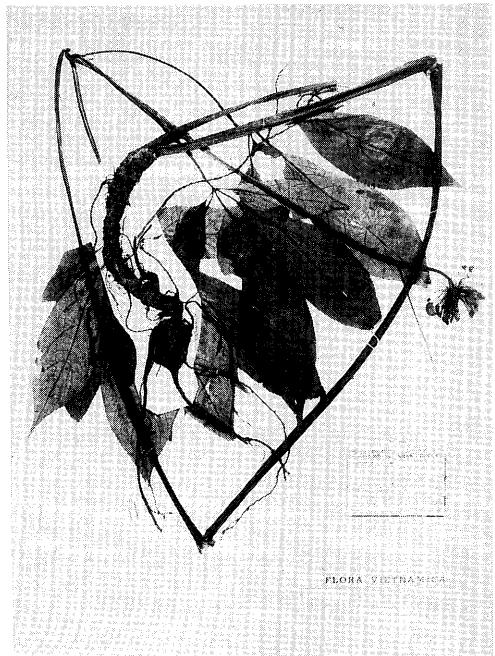


Fig. 2. Type of *Panax vietnamensis* Ha et Grushv.

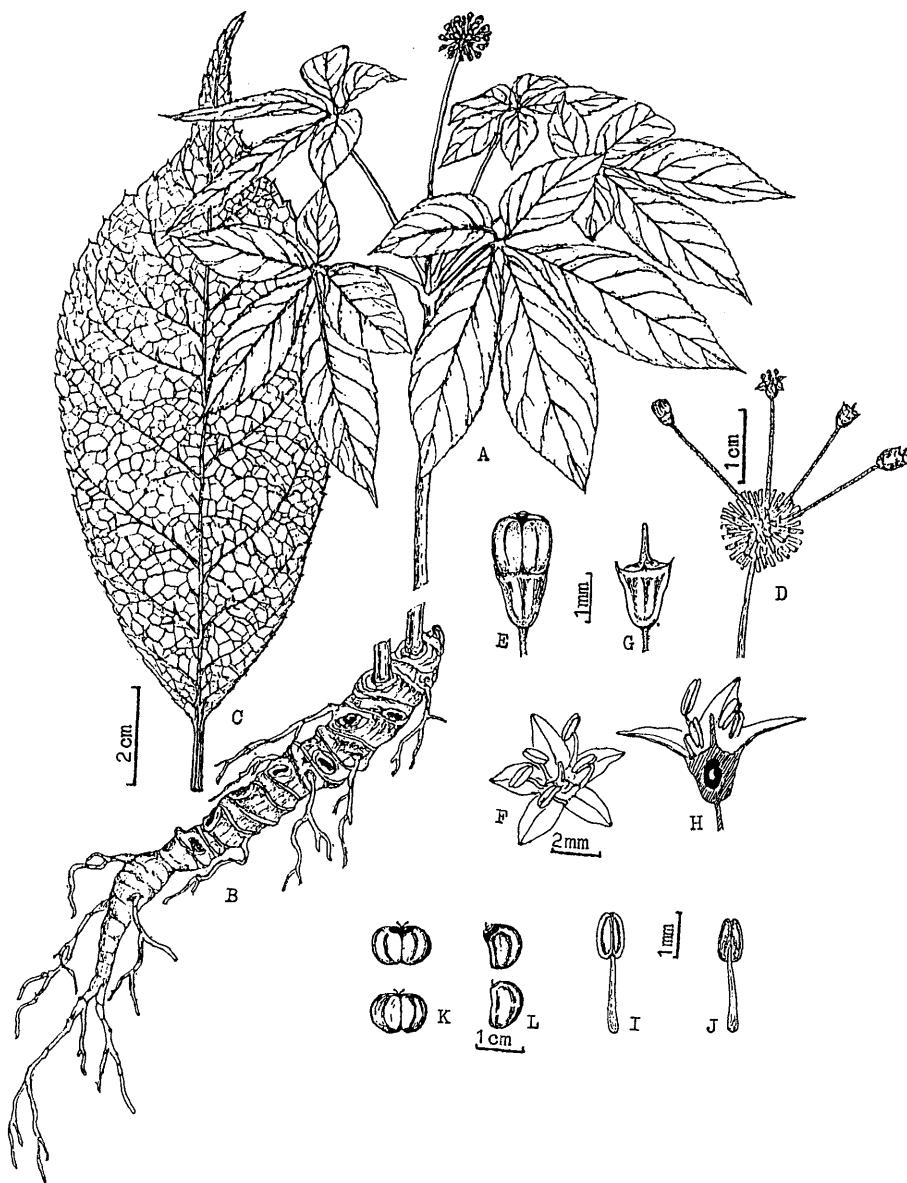


Fig. 3. General description of organs of *Panax vietnamensis* Ha et Grushv. A. Aerial parts. B. Underground parts (rhizome and root). C. Leaflet. D. Part of an umbel of flowers. E. Flower bud. F. An open flower. G. Flower after separation of its petals and stamens. H. Transversal section of flower. I-J. Stamens. K. Two-seeded fruit (15%, with and without black spot on the apex of the fruit). L. One-seeded fruit (85%, with and without black spot on the apex of the fruit).

are sometimes found, but fruits containing three or more seeds have not been found as yet. Data recorded for 4,910 mature fruits are as follows. Fruits with one seed: 85.3%; those with two seeds: 14.7%. Fruits with black spot: 98.8%; those without black spot: 1.2%.

Rhizome: Main organ for medicinal use. Light yellow or yellow-brown, lightly scented, bitter and slightly sweet. Rhizome has many nodes like bamboo, bearing scars of preceding aerial stems which wither yearly. Each scar may therefore represent one year of

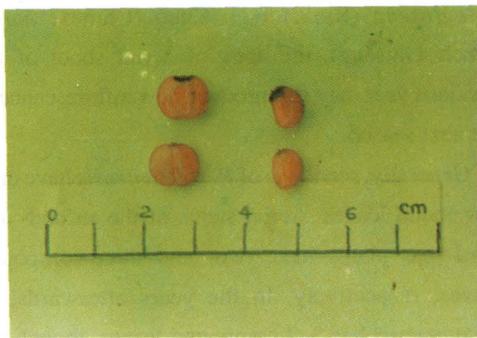


Fig. 4. Variation of fruits. Upper right. One-seeded fruit with black spot. Upper left. Two-seeded fruit with black spot. Lower left. One-seeded fruit without black spot. Lower right. Two-seeded fruit without black spot.

age. The shape of rhizomes of the wild plants varies greatly. The length and diameter of wild rhizomes depend on the age of the plant, commonly 20–25 cm long and 1–3.5 cm in diameter for the plants aged 15–20 years. In case of the more aged plants (30–40 years old), rhizomes are commonly coiled up on the ground. In 1978, a wild *P. vietnamensis* with a rhizome of 90 cm long and 710 g by weight, bearing sixty two scars (62 years old), was collected. In 1983, another aged wild plant with rhizome (780 g), bearing seventy two

scars, was collected. Rhizome bears numerous adventitious roots which are rippling along nodes and is easily broken off.

Tuber Root: Lightly yellow color, horizontally striate and bearing numerous radicles. In wild *P. vietnamensis*, a tube root is the least developed organ with cylindrical or spinning-top shape, sometimes human shape. In 1978, one gross tuber root (200 g) of 10 cm long and 5 cm in diameter was collected.

As to the cultivated *P. vietnamensis*, some noteworthy variations were observed. The main difference between the wild and cultivated plants is the shape of root. A tuberous root of the cultivated plant obviously develops every year and becomes the main part of the underground part, but the rhizome is short and small. The adventitious root swells out and becomes progressively tuberous. The following three shapes are observed for the cultivated roots: carrot-like shape, spinning-top-like shape and fascicle of carrot-like shape (the most popular).

The anatomical structure of the diverse organs including rhizome, tuber root, radicle, aerial stem and leaf (midrib, blade and rigid hair on the blade) has been studied.

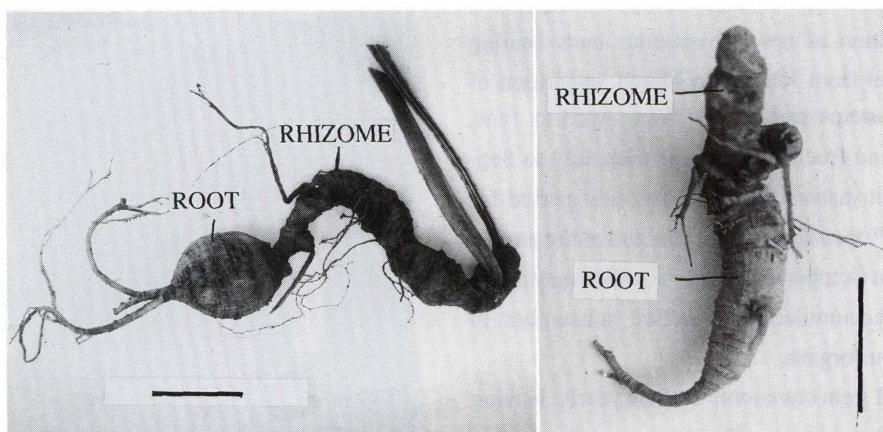


Fig. 5. Wild rhizomes and roots *Panax vietnamensis*. Left. Spinning top-like shape (200g in weight). Right. Carrot-like shape. Bar indicates 5 cm.

Some Eco-physiological Characteristics of *Panax vietnamensis*

It has been observed that *P. vietnamensis* appears at the altitude of more than 1,500 m but grows well in high density at altitude of 1,700–2,000 m under the canopy of evergreen forests composed of broad-leaf and needle-leaf trees. This plant is hygrophilous and generally grows in gregarious patches along the shady sides of streams where the humidity of air and soil is always over 80% and the percentage of organic humus is very high in soil. However, in the place which is far from streams but rich in humus and sufficiently humid and shady, *P. vietnamensis* can grow as well. The optimal climatic parameters are as follows: the mean annual temperature is 18–20°C; the absolute lowest temperature during the coldest months may be lower than 0°C; the absolute highest temperature is not over 25°C under the forest canopy; the great difference between day and night temperatures is requested; the quantity of light received is very low (about 25–30% of total light); sunny hours are 3–6 a day; the humidity is over 80%.

The growth period of *P. vietnamensis* is variable, depending upon the localities due to the differences of topography and weather. The common growth cycle for a year is as follows: from October to December, aerial stems of the previous year progressively wither with apparition of new adventitious buds bearing future umbel from January to March, apparition of new aerial stems and umbels from April to June, flowering and fructifying season from July to September, fruit maturing season. The best period for harvesting *P. vietnamensis* is at the end of the growth season, from October to December, which may be the period of accumulation of active substances in subterraneous organs.

An aerial stem commonly withers yearly, leaving a scar on the rhizome. The stem sometimes may remain for three years, but is not able to produce a new inflorescence any more. In contrast to this, in *Panax*

notoginseng (Burk.) F.H. Chen (Chinese name: Sanchi-Ginseng), the apex of aerial shoot of the previous year may still produce new inflorescence in the next season.

Generally, seedlings of *P. vietnamensis* have one-compound leaves. Aerial stems of the second- and third-year plants have two- and three-compound leaves, respectively. In the years afterwards, *P. vietnamensis* has 3–7 compound leaves, though the plants with six- and seven-compound leaves are rare. However, under the malnutritional conditions, even the fourth- and fifth-year plants still have two-compound leaves.

The inflorescence generally appears on the plant with at least three-compound leaves (grown-up plant). Umbel of flowers is formed just in the resting bud and appears at the same time as apparition of the new



Fig. 6. Whole plant of a cultivated *Panax vietnamensis*.

shoot. This feature is similar to that of *P. ginseng* but completely different from *P. notoginseng* whose umbel of flowers is formed only in the period of growing-up of the shoot.

Flowers open in the morning, 9–11 a.m. (temperature: 18–20°C; humidity: 85–90%), progressively from the margins of inflorescence to the center. Petals fall one or two days after, and the fructification begins.

Generally, ripening of the fruits is observed in the center of the umbel. After two months, the color of matured fruits changes from dark green to orange-red with a black spot on the top. The maximum number of the fruits on an umbel may reach 40, but the fruits conformable to the norm of planting are commonly only 10–15.

The subterraneous organ of *P. vietnamensis* is essentially the rhizome which develops horizontally on the ground among the superficial humus layer. Mostly, long rhizomes of the high aged plants roll on the ground. Each node of the rhizome may germinate, giving a small plant with one-compound leaves. Especially, the top of a rhizome of the grown-up plant may give a shoot with three-compound leaves and umbel of flowers, and after one year we can harvest seeds. The capacity of regeneration of the rhizome is very strong, which is a characteristic of *P. vietnamensis*.

Saponin Composition

From rhizomes and roots of *P. vietnamensis*, the following major dammarane-saponins were isolated and identified in a yield indicated in parenthesis (Duc et al. 1993). Known saponins of 20(S)-protopanaxadiol: ginsenosides-Rb1 (2.0%), -Rb3 (0.1%), and -Rd (0.9%); known saponins of 20(S)-protopanaxatriol: ginsenosides-Re (0.2%), -Rg1 (1.4%), and notoginsenoside-R1 (0.4%); known ocotillol-type saponins: majonosides-R1 (0.1%) and -R2 (5.3%). Recently, further study on saponins of the rhizomes and the roots led to the isolation of a number of known and new minor dammarane saponins to-

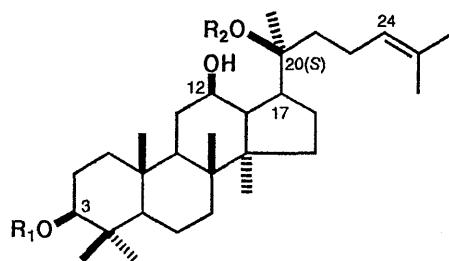
gether with a small amount of oleanolic acid saponins (Duc et al. 1994).

Until recently, saponin compositions of most of *Panax* spp. have been elucidated (Tanaka et al. 1984; Tanaka 1990, 1991, 1994). Rhizomes of *Panax* spp., growing in Eastern Himalayas through South-Western China and Japan, contain a large amount of oleanolic acid saponins along with dammarane saponins. On the other hand, saponin compositions of underground parts of *P. ginseng*, *P. quinquefolium* L. (American Ginseng), *P. notoginseng* and the species collected in Central Nepal are mainly composed of dammarane saponins with (or without) a relatively small amount of oleanolic acid saponins. The saponin composition of *P. vietnamensis* is similar to that of the latter group. However, it is noteworthy that rhizomes of *P. vietnamensis* contain a large amount of the ocotillol-type saponins which have not been isolated from Ginseng roots, American Ginseng and Sanchi-Ginseng.

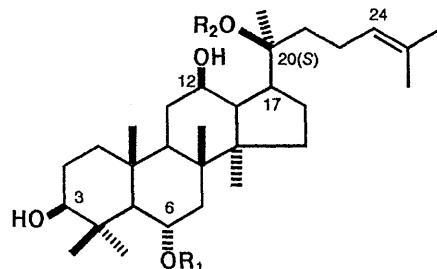
Polyacetylene alcohols which are cytotoxic against some cultured cancer cells have been isolated from Ginseng roots. The same and the similar polyacetylene alcohols were also isolated from *P. vietnamensis*.

Pharmacological Study

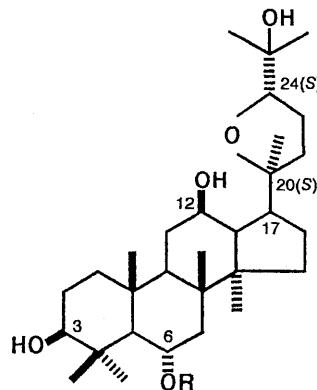
Pharmacological activities of Ginseng and its saponins in rats or mice have extensively investigated since 1970 (Shibata et al. 1985, 1990). In comparison with the biological activities of Ginseng, pharmacological studies on *P. vietnamensis* extract (in animals) have been carried out in Vietnam. The analeptic, antifatigue and adaptogenic activities were observed in the extracts. Stimulation of the central nervous system (CNS) was observed in small doses, while in larger doses, the extract depressed CNS and showed antipsychotic action. Increase of weight of male and female sexual organs, anti-arteriosclerotic action, hypotensive action to the hypotensive animals, hypoglycemic action, and protective and regenerative



	yield	R ₁	R ₂
ginsenoside Rb ₁	2.0%	-Glc ² -Glc	-Glc ⁶ -Glc
ginsenoside Rb ₃	0.1%	-Glc ² -Glc	-Glc ⁶ -Xyl
ginsenoside Rd	0.9%	-Glc ² -Glc	-Glc



	yield	R ₁	R ₂
ginsenoside Re	0.2%	-Glc ² -Rha	-Glc
ginsenoside Rg ₁	1.4%	-Glc	-Glc
notoginsenoside R1	0.4%	-Glc ² -Xyl	-Glc



	yield	R
majonoside R1	0.1%	-Glc ² -Glc
majonoside R2	5.3%	-Glc ² -Xyl

Glc: β-D-glucopyranosyl; Xyl: β-D-xylopyranosyl; Rha: α-L-rhamnopyranosyl

Fig. 7. Major saponins from rhizomes and roots of *Panax vietnamensis*.

actions against hepatic damage were observed in animal experiments.

The following two activities were newly observed for *P. vietnamensis* extract and *P. vietnamensis* saponin mixture. Increase of cytochrome P-450 content in liver microsomes and anti-bacterial activities against pathogenic *Streptococcus* spp. without influence on useful microorganisms of intestinal tract.

Clinical evaluation of *P. vietnamensis* extracts for aged patients and post operation patients were conducted at Institute of Gerontology, Ha-Noi, Central Army Hospital and Sanatorium for Patients in Convalescence, Ho Chi Minh City. The following positive results have been obtained: general tonic effect, anti-fatigue action, increase of appetite and better sleep, improvement of muscular force and mental state, improvement of memory test and articulation, relief from pains in bones, recovering from anemia, arteriosclerosis, mental, physical and sexual asthenia, chronic granular angina and release of bronchial asthma with antitussive action.

Toward the commercial use of *P. vietnamensis* extract as a medicine and a health food, large scale cell-culture of this plant is under progress, which will be reported elsewhere in detail.

The cooperative study on Vietnamese Ginseng has been promoted under the financial support by a Grant-in-Aid (Monbusho International Scientific Program, No. 03044103, Organizer: O. Tanaka, 1991–1993) from the Ministry of Education, Science and Culture, to whom our thanks are due.

G. T. ニヤム, P. V. デ, T. C. ルアン, G. M. ドウク, 柴田承二, 田中 治, 笠井良次: ベトナム人參 *Panax vietnamensis* Ha et Grushv. (ウコギ科)に関する生薬学的及び化学的研究

ウコギ科トチバニンジン属 *Panax* の 1 新種が 1973 年ベトナム中部 Dakto 地方の海拔 1,800m の山岳地帯で発見され, 1985 年 Dung および

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 Zhou J., Huang W., Wu M., Yang C., Wu C. and Huang K. 1975. Triterpenoids from *Panax* Linn. and their relationship with taxonomy and geographical distribution. Acta Phytochemica Sinica **13**: 29–48.
- Grushvisky により *Panax vietnamensis* Ha et Grushv. と命名された。本植物の根および根茎は現地住民によって古くから強壮剤的な秘薬として使用されていた。本植物の地上部の形態は同属の *P. ginseng* オタネニンジン等に類似するが、赤く

熟する果実のほとんどには特長的に黒い斑点があり、その85%は1個の種子しか持っていない。

本植物は北緯15° 東経108° 一帯の海拔1,500m以上の高地でベトナムの最高峰ニヨクリン山(2,595 m)を含む地域に広く分布する。現在は野生株の保存と共に栽培が行われている。野生株は根茎が長く発達しその先に多くの場合塊状の根をつけるが、栽培株では食用ニンジン様の形態の主根が発達する。毎年10-12月地上部は枯れ、1月-3月に新しい地上部が出現し、4-6月に花期と結実期を迎える。7月-9月に完熟期となる。地下部の収穫には10月-12月が適期である。

本植物の根茎および根には人参、三七人参と同

様にダンマラン系トリペルテンサポニンを含有し ginsenoside Rb-1, Rb-3, R-d, R-e, Rg-1, notoginsenoside R-1 等が存在するが人参、三七人参には出現しないオコチロール系の majonoside R1 や R2 が存在し、とくに majonoside R2 の含有が著しく高い(5.3%)のが特長的である。

ベトナム人参の薬理学的研究では人参などと同様に強壮、抗疲労、中枢作用、ホルモン作用増強などの他、血圧、血糖値の正常化、肝障害の回復、抗菌性、過酸化脂質抑制などの活性が認められている。ベトナムでは更にベトナム人参の老年者や手術後の患者に対する臨床医学的研究も行われている。